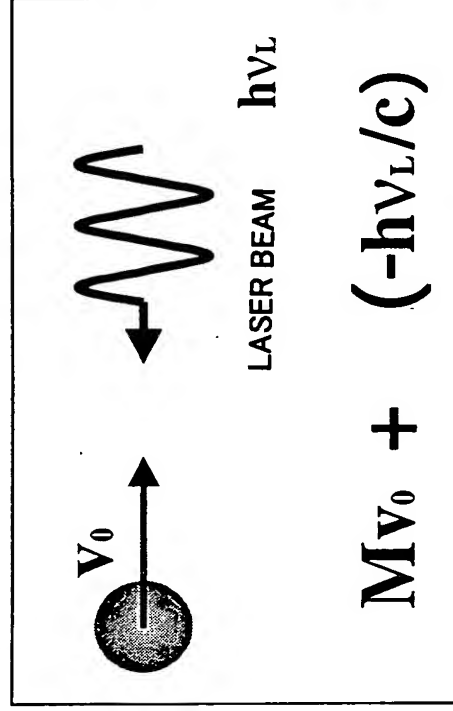


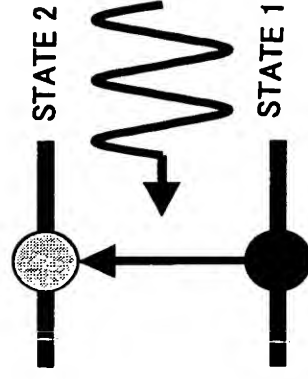
FIG. 1

FORCE ACTS ON NEUTRAL ATOM (SCATTERING FORCE)

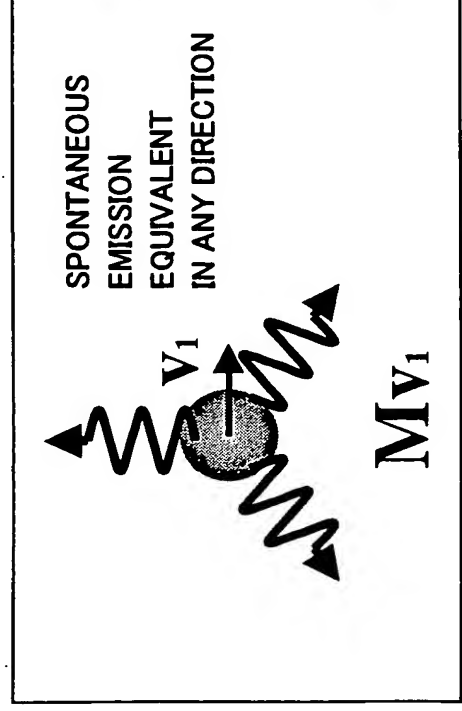
•LIGHT ABSORPTION OF ATOM IN MOTION WITH CONSTANT VELOCITY



$$\begin{aligned}
 V_L &= V_0 \cdot c/(c+V_0) \\
 &= V_0 \cdot \{1 - V_0/(c+V_0)\} \\
 &< V_0
 \end{aligned}$$



•LIGHT EMISSION OF ATOM IN MOTION WITH CONSTANT VELOCITY



$$\begin{aligned}
 F &= \Delta P/(2\tau) = M(V_0 - V_1) / (2\tau) \\
 &= h\nu_L / (2\tau c)
 \end{aligned}$$

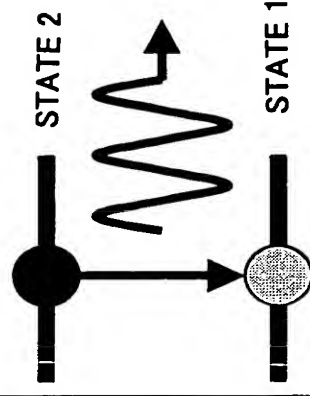


FIG. 2

STOP TIME

$$t = 2N\tau = 2 \cdot 11476 \cdot 5.524861878\text{ns} = 126.8 \mu\text{s}$$

NATURAL WIDTH

$$\Delta\nu (= \gamma) = 1/(2\pi\tau) = 1/(2 \times 3.141592654 \times 5.52486\text{ns}) = 28.807054\text{MHz}$$

$$\text{Doppler COOLING TEMPERATURE } k_{\text{TD}} = h/(2\pi) \cdot \gamma = 6.6260755 \times 10^{-34} \cdot 1/2 / 3.141592654 / (2 \times 3.141592654 \times 5.52\text{ns}) = 220.227 \mu\text{K}$$

FIG. 3

Doppler WIDTH

$$\Delta \nu_d = 2 \nu_0 \left(\frac{2k_B T}{Mc^2} \right) \ln 2^{1/2} = 2 \cdot 1.18735651 \times 10^{15} \cdot (2 \times 1.380658 \times 10^{-23} \times T / (27.976957 \cdot 1.6605402 \times 10^{-27} \times 2.99792458 \times 10^8 \times 2.99792458 \times 10^8) \cdot \ln 2)^{1/2} = 160.7815759 \cdot T^{1/2} \text{ MHz}$$

IN GASEOUS MOLECULE IN THERMAL EQUILIBRIUM, ATOMS EXHIBIT IRREGULAR BROWNIAN MOVEMENT, EACH ATOM POSSESSES SLIGHTLY DIFFERENT RESONANCE FREQUENCY FROM ONE ANOTHER, AND POSSESSES NATURAL WIDTH IN EACH ATOM.

ACCORDINGLY, AS IN CASE OF GASEOUS MOLECULE, ENVELOPE IN SPECTRAL DISTRIBUTION OF SPONTANEOUS EMISSION REFLECTS ON DISPERSION IN CENTER FREQUENCY OF EACH ATOM. SUCH BROADENING IS CALLED BY NAME OF INHOMOGENEOUS BROADENING.

Doppler WIDTH AT MELTING TEMPERATURE $6045.9 \text{ MHz} = 6.0459 \text{ GHz}$

FIG. 4(a)

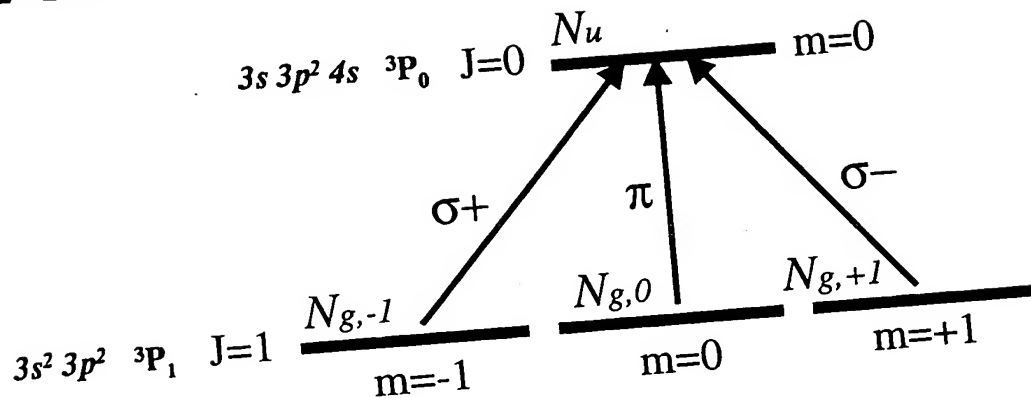


FIG. 4(b)

$$\begin{aligned} \frac{dN_u}{dt} &= W_{\sigma+} + W_{\pi} + W_{\sigma-} - \frac{N_u}{\tau} \\ \frac{dN_{g,-1}}{dt} &= -W_{\sigma+} + \frac{N_u}{3\tau} \\ \frac{dN_{g,0}}{dt} &= -W_{\pi} + \frac{N_u}{3\tau} \\ \frac{dN_{g,+1}}{dt} &= -W_{\sigma-} + \frac{N_u}{3\tau} \end{aligned}$$

FIG. 4(c)

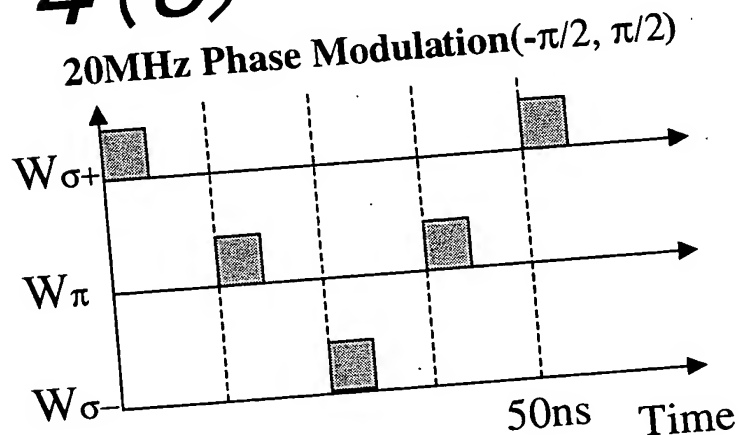


FIG. 5

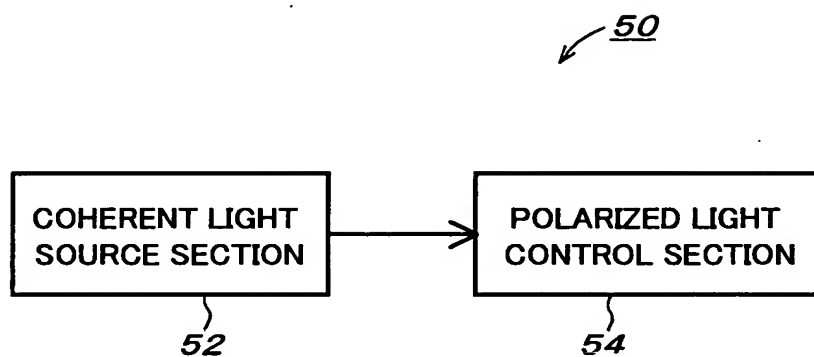


FIG. 6

BIREFRINGENCE CRYSTAL

n_o : REFRACTIVE INDEX IN ORDINARY RAY

n_e : REFRACTIVE INDEX IN EXTRAORDINARY RAY

WHERE $n_o < n_e$ (PHASE DELAYS IN n_e -AXIS)

$$\Phi = 2 \pi (n_o - n_e) d / \lambda$$

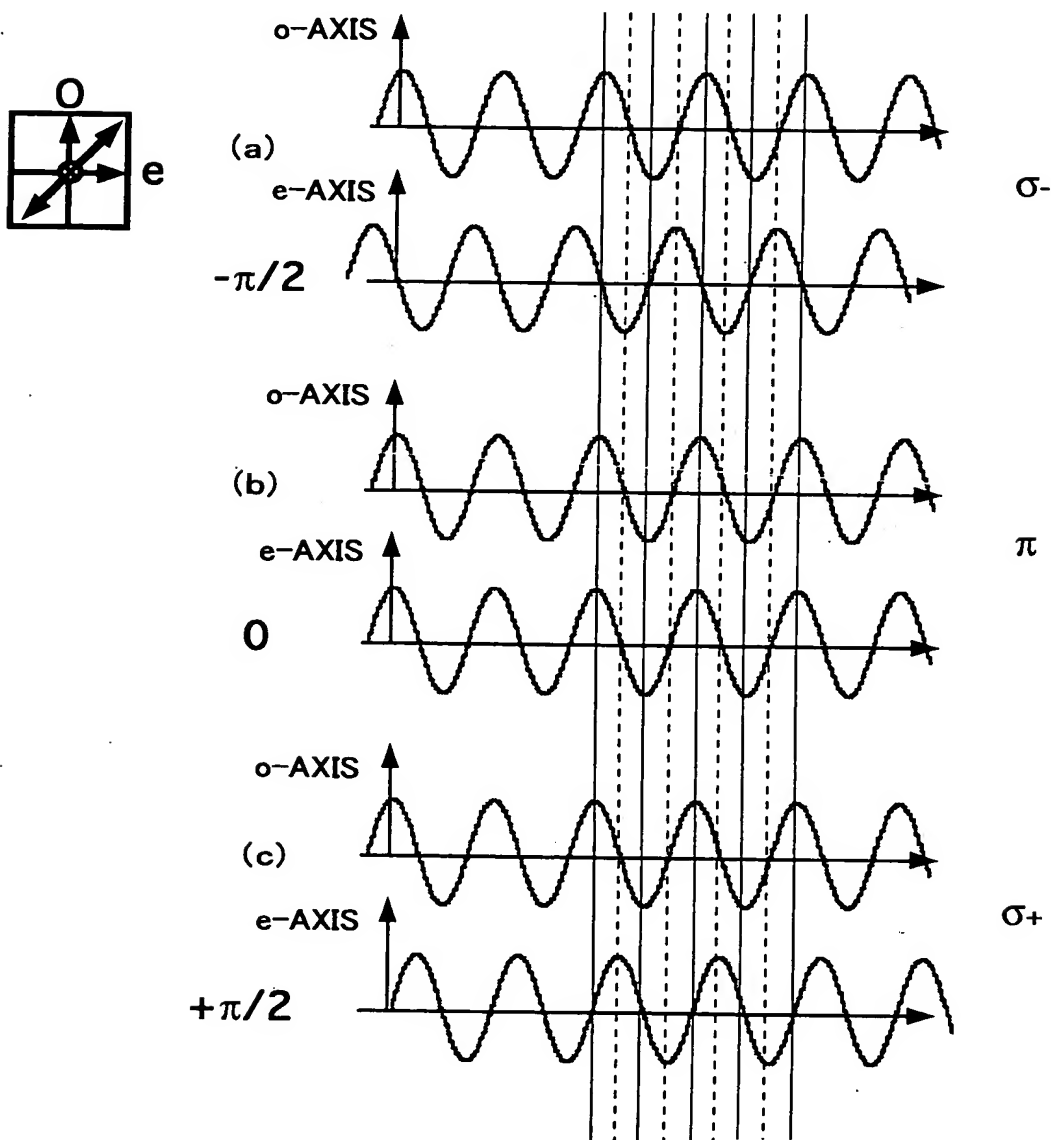
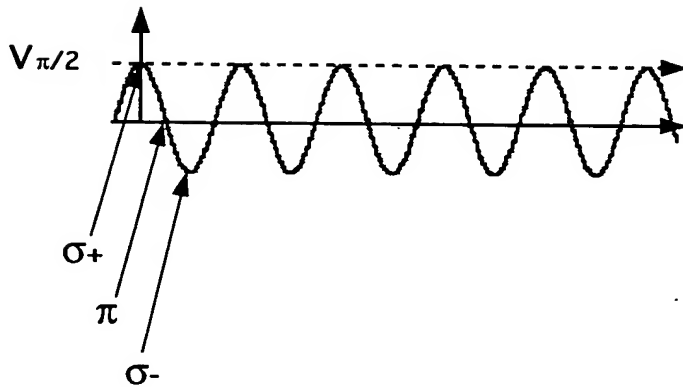


FIG. 7



TIME REQUIRED FOR ABSORPTION - EMISSION
OF ONE PHOTON

$$: 2\tau = 11\text{ns} \quad (\tau = 5.5\text{ns})$$



IT IS EFFICIENT WHEN NEXT PHOTON STRIKES AFTER 11 ns

$$\text{PERIOD } 11\text{ns} \times 4 = 44\text{ns} \quad -> \quad \text{FREQUENCY IN PHASE MODULATOR} \quad f_m < 22.7\text{MHz}$$

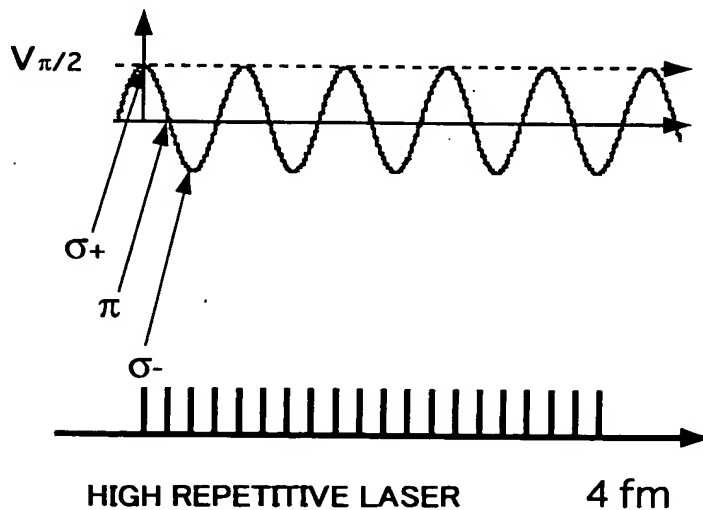
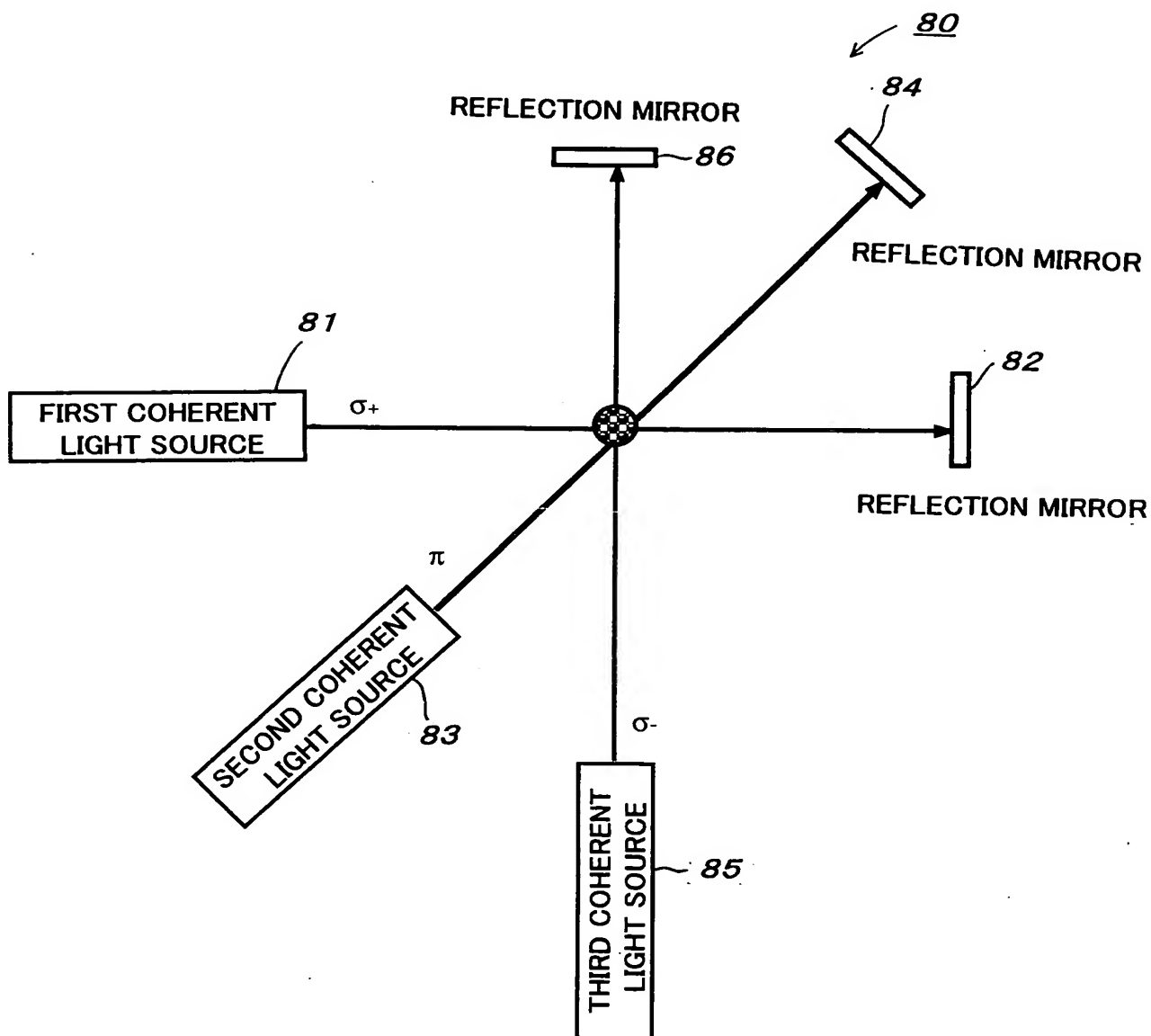


FIG. 8(a)

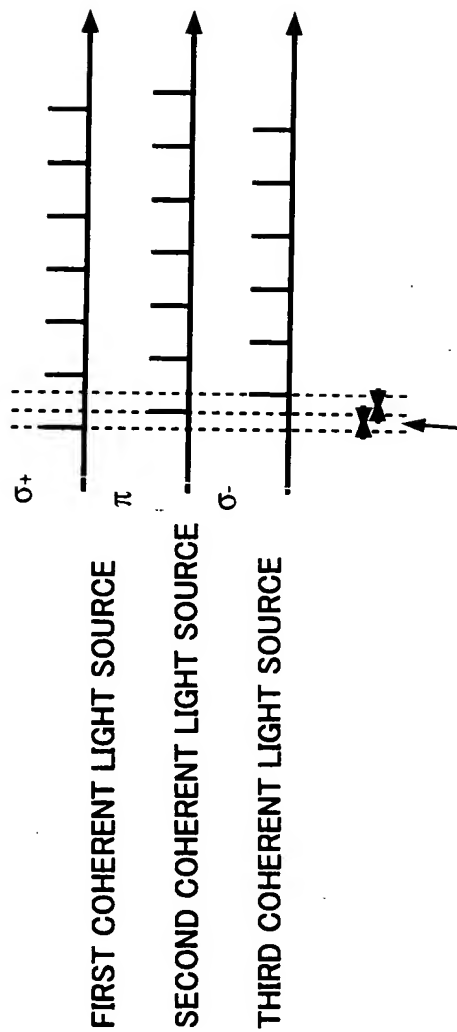
POLARIZED LIGHT CONTROL BY THREE COHERENT LIGHT SOURCE DEVICES



NO SIMULTANEOUS EMISSION

COHERENT EFFECT APPEARS SO THAT EFFICIENT COOLING
CANNOT BE MADE

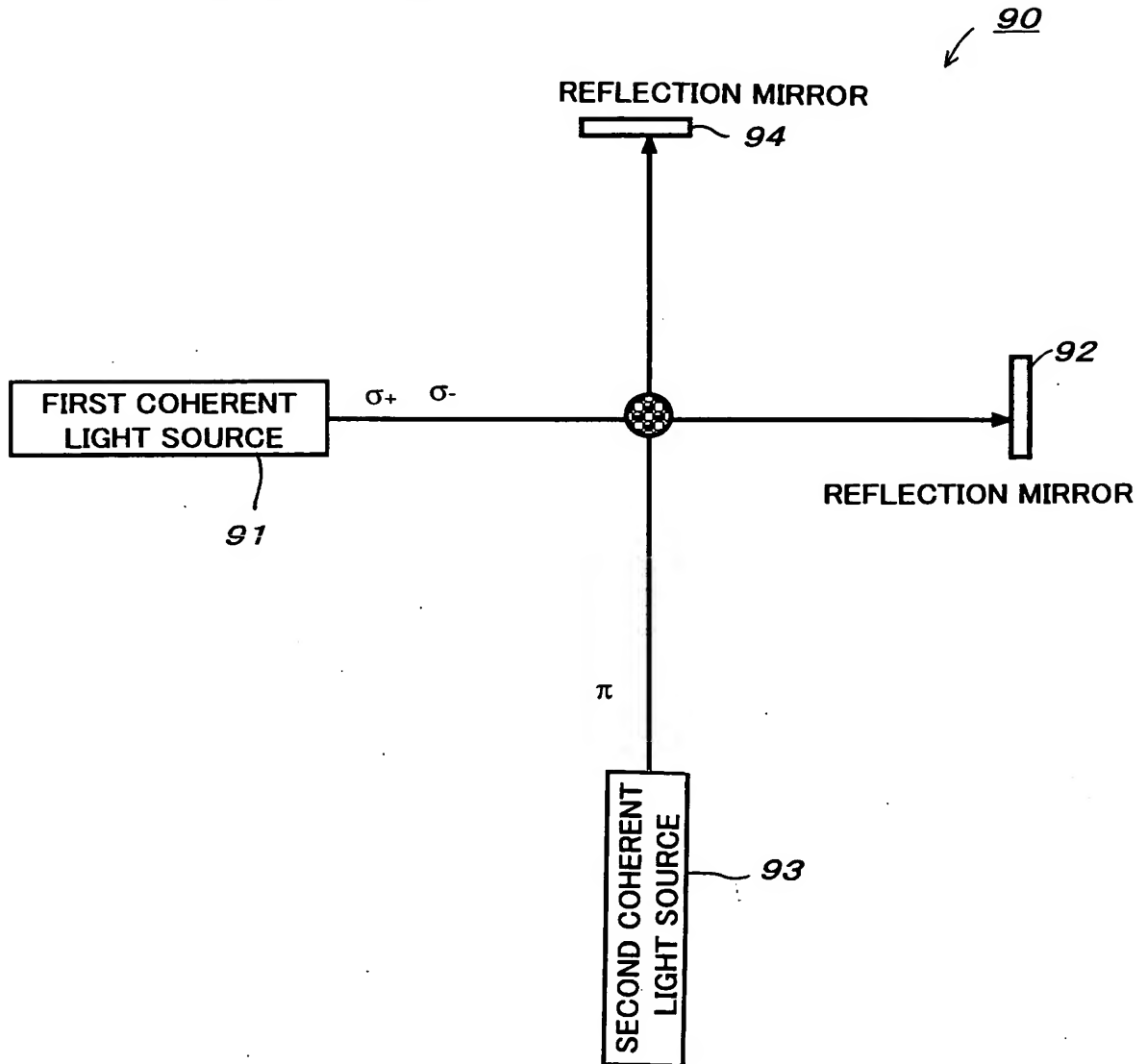
FIG. 8(b)



OPTIMUM IS TWO TIMES LONGER THAN LIFETIME OF SPONTANEOUS EMISSION
(11 ns IN CASE OF SILICON)

FIG. 9(a)

POLARIZED LIGHT CONTROL BY TWO COHERENT LIGHT SOURCE DEVICES



NO SIMULTANEOUS EMISSION

COHERENT EFFECT APPEARS SO THAT EFFICIENT COOLING
CANNOT BE MADE

FIG. 9(b)

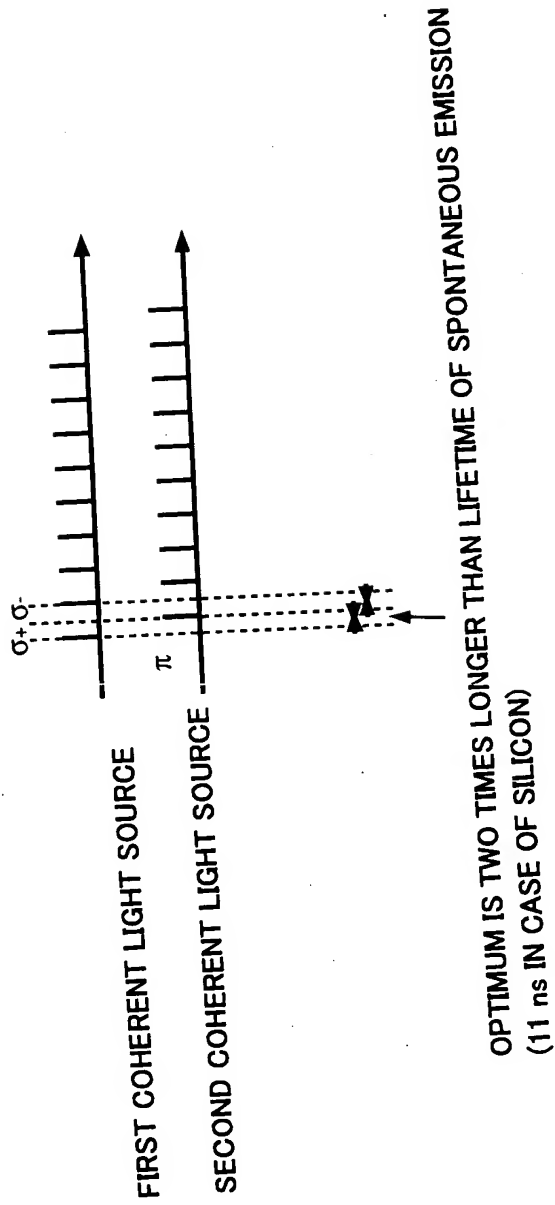
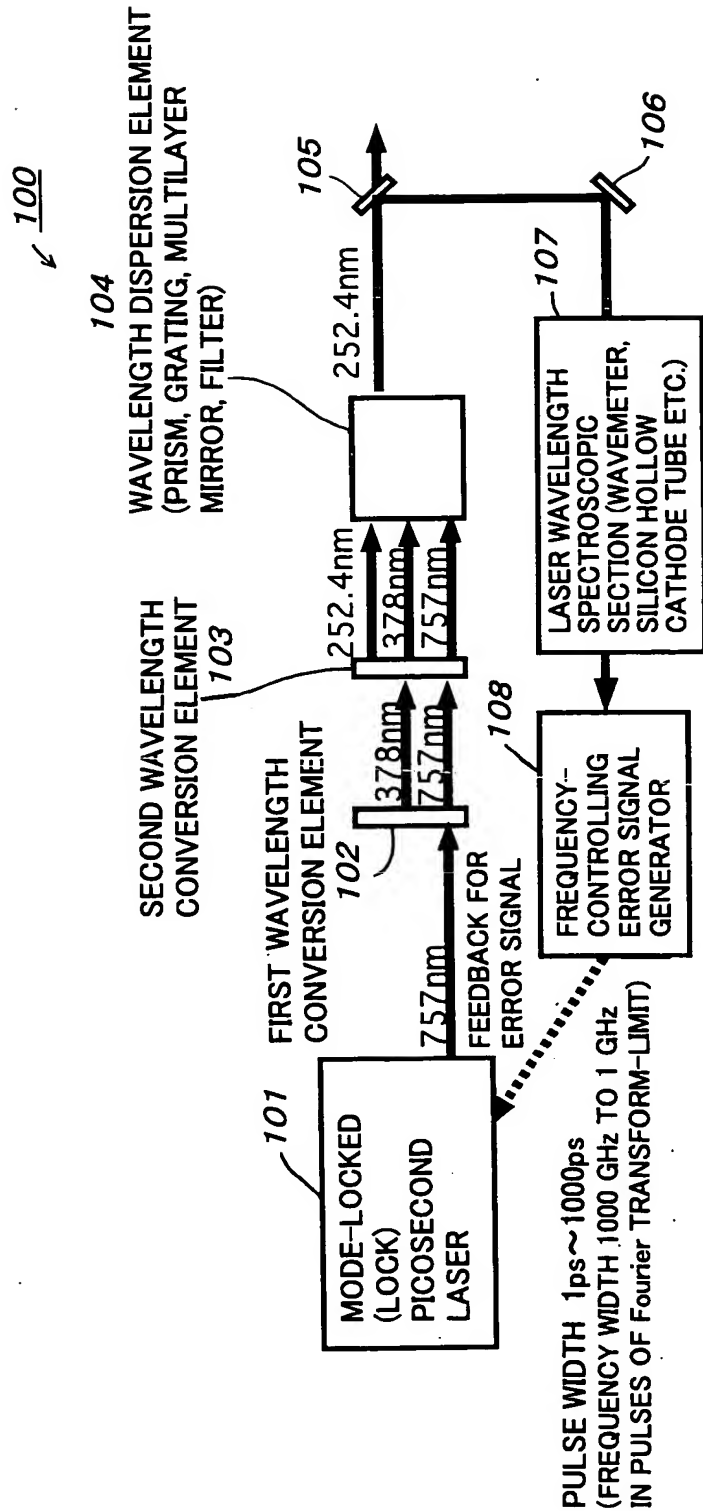


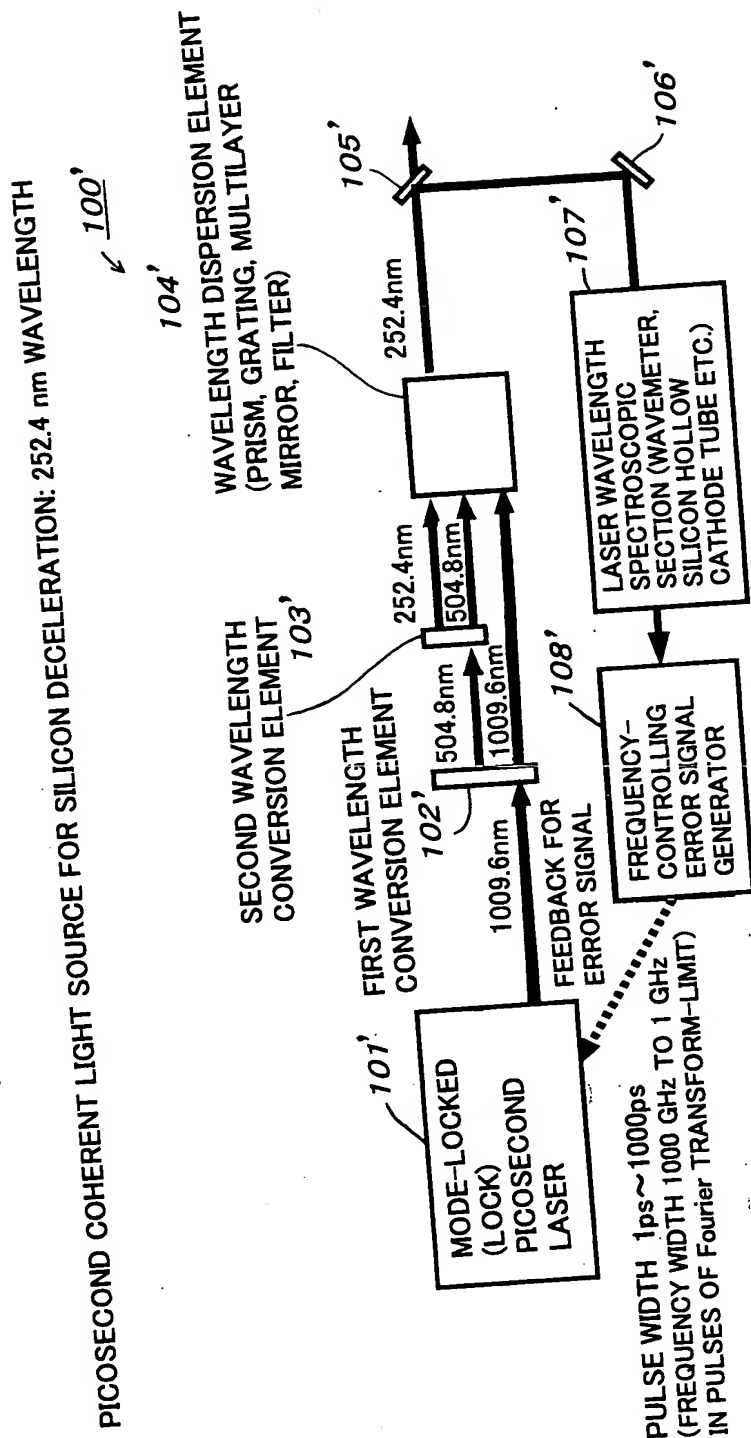
FIG. 10

PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION: 252.4 nm WAVELENGTH



378 nm CORRESPOND TO SECOND HARMONICS OF 757 nm,
AND 252.4 nm CORRESPOND TO THIRD HARMONICS OF 757 nm

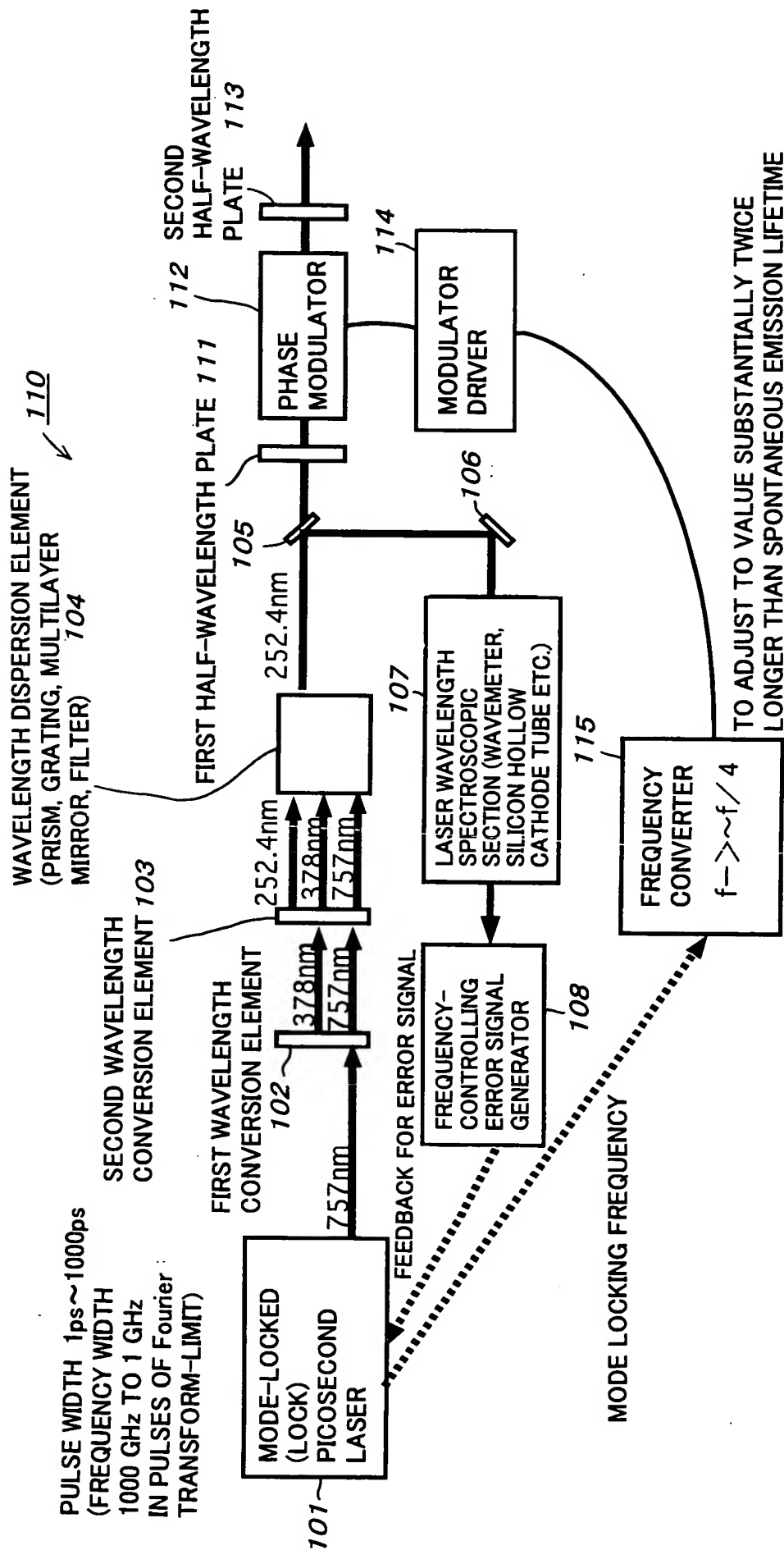
FIG. 11



504.8 nm CORRESPOND TO SECOND HARMONICS OF 1009.6 nm,
AND 252.4 nm CORRESPOND TO SECOND HARMONICS OF 504.8 nm

FIG. 12

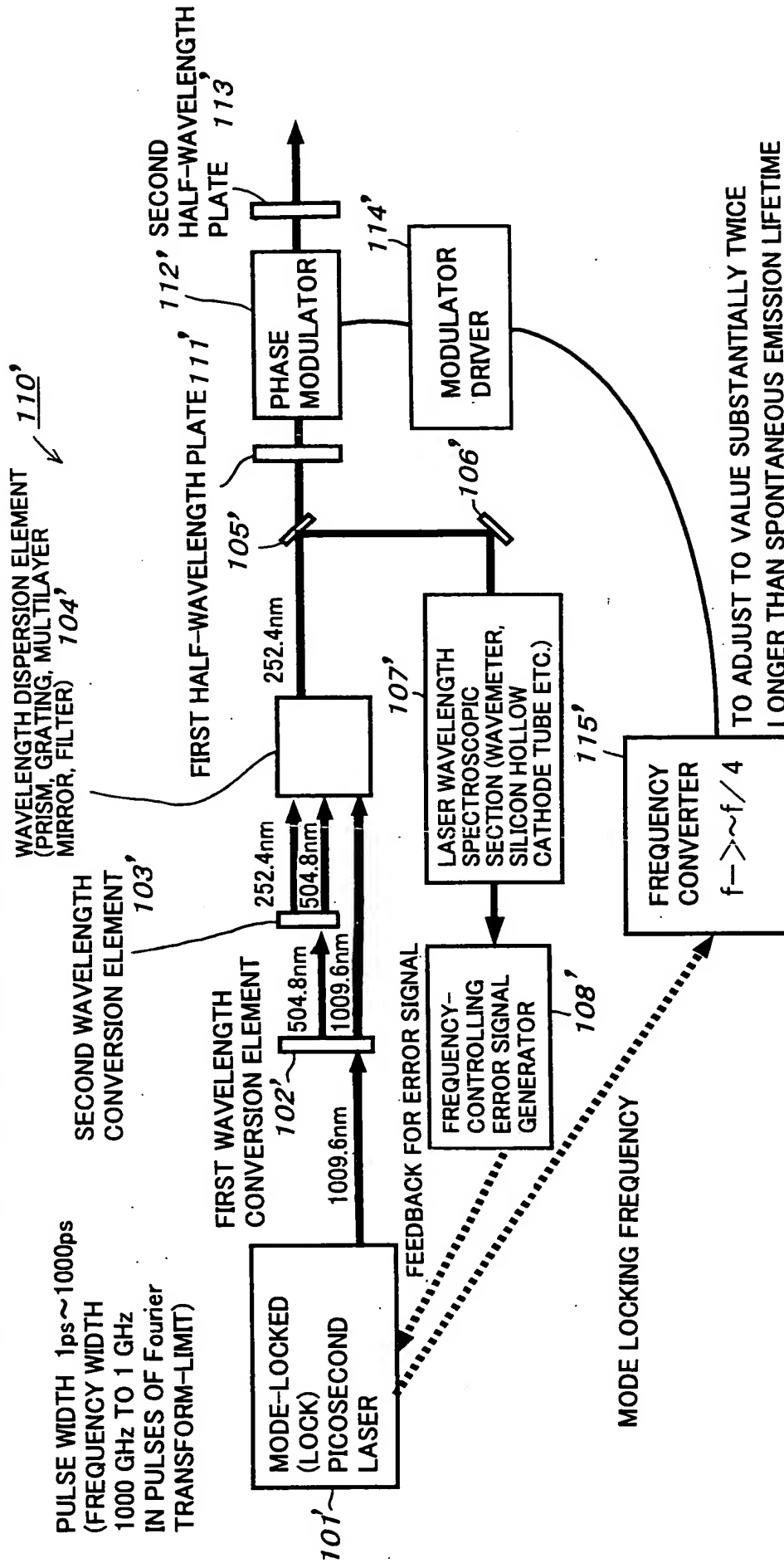
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH



378 nm CORRESPOND TO SECOND HARMONICS OF 757 nm,
AND 252.4 nm CORRESPOND TO THIRD HARMONICS OF 757 nm

FIG. 13

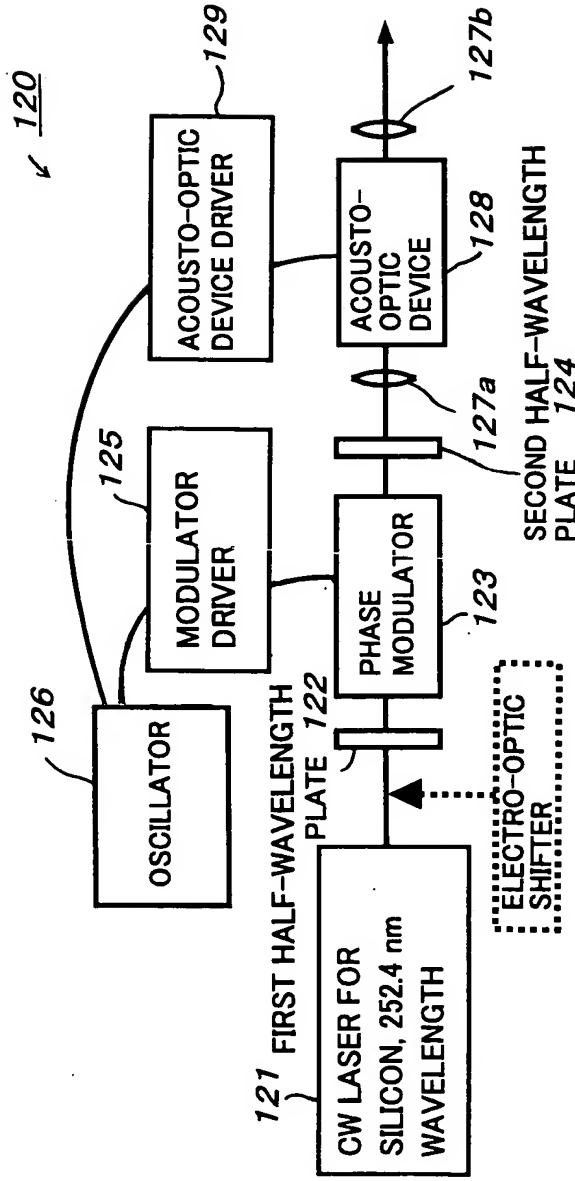
PICOSECOND COHERENT LIGHT SOURCE FOR SILICON DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH



504.8 nm CORRESPOND TO SECOND HARMONICS OF 1009.6 nm,
AND 252.4 nm CORRESPOND TO SECOND HARMONICS OF 504.8 nm

FIG. 14

CW COHERENT LIGHT SOURCE FOR SILICON DECELERATION/COOLING TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 252.4 nm WAVELENGTH



SILICON DECELERATION: FREQUENCY IS CHANGED TIME-VARYINGLY BY USE OF ACOUSTO-OPTIC DEVICE (CHIRPED COOLING)

SILICON COOLING: ACOUSTO-OPTIC DEVICE HAS EFFECT FOR SEPARATING POLARIZED LIGHT AND ADVANTAGEOUS FOR OPTIMIZING FREQUENCY

THERE IS CASE EFFECTIVE FOR CHIRPED COOLING BY INCREASING FREQUENCY SHIFT AMOUNT WITH ADDITION OF ELECTRO-OPTIC SHIFTER (EO SHIFTER)

FIG. 15

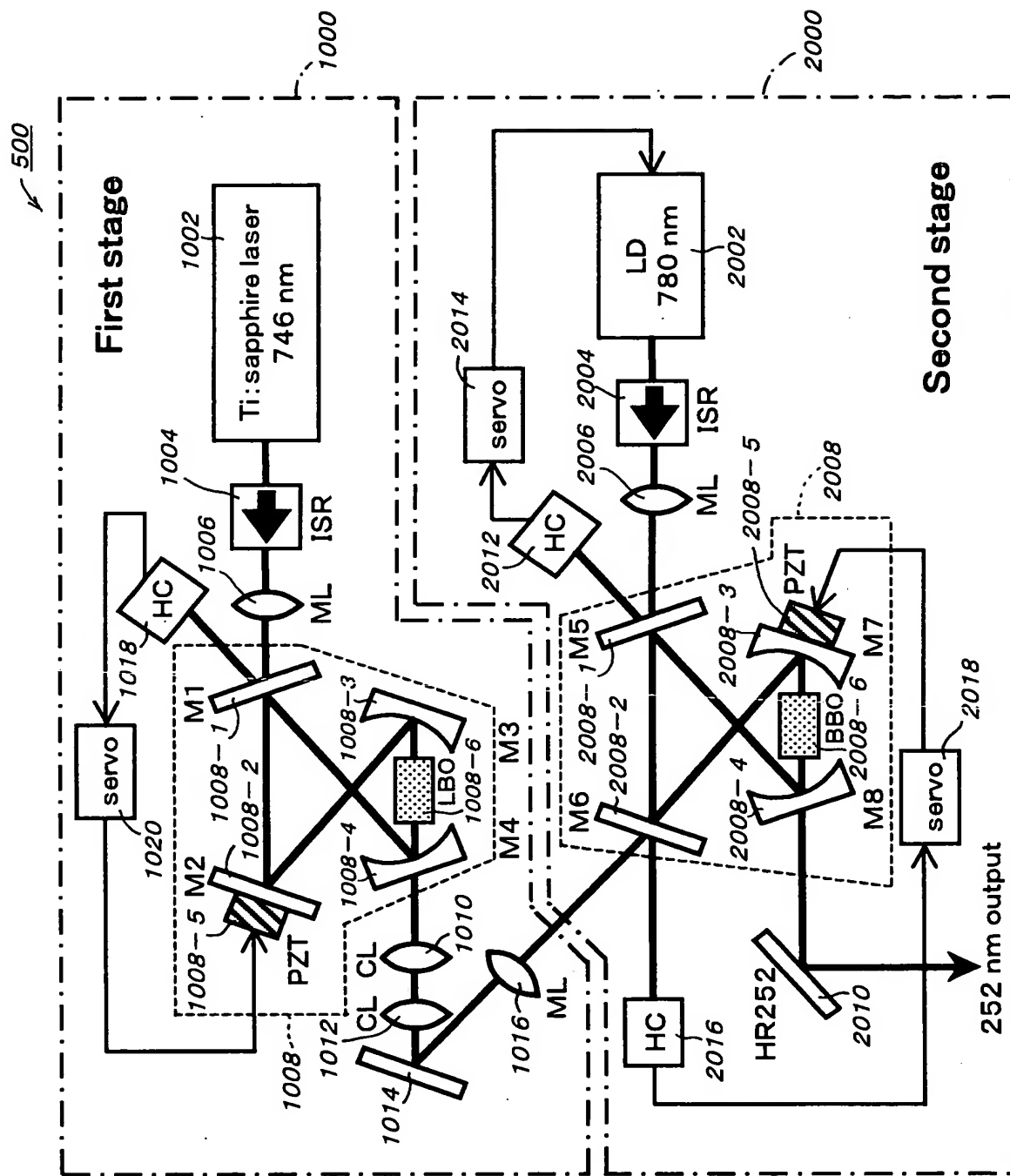


FIG. 16

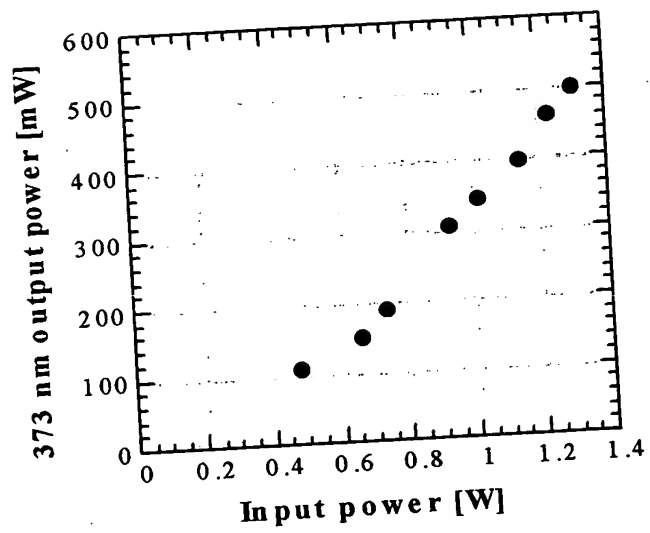


FIG. 17

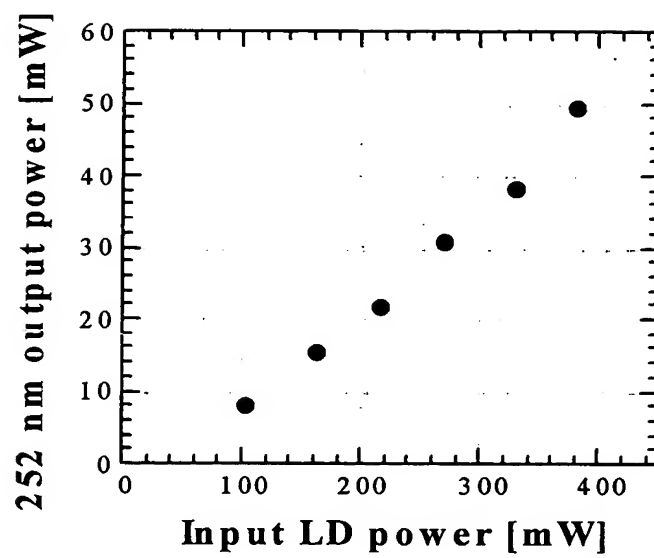
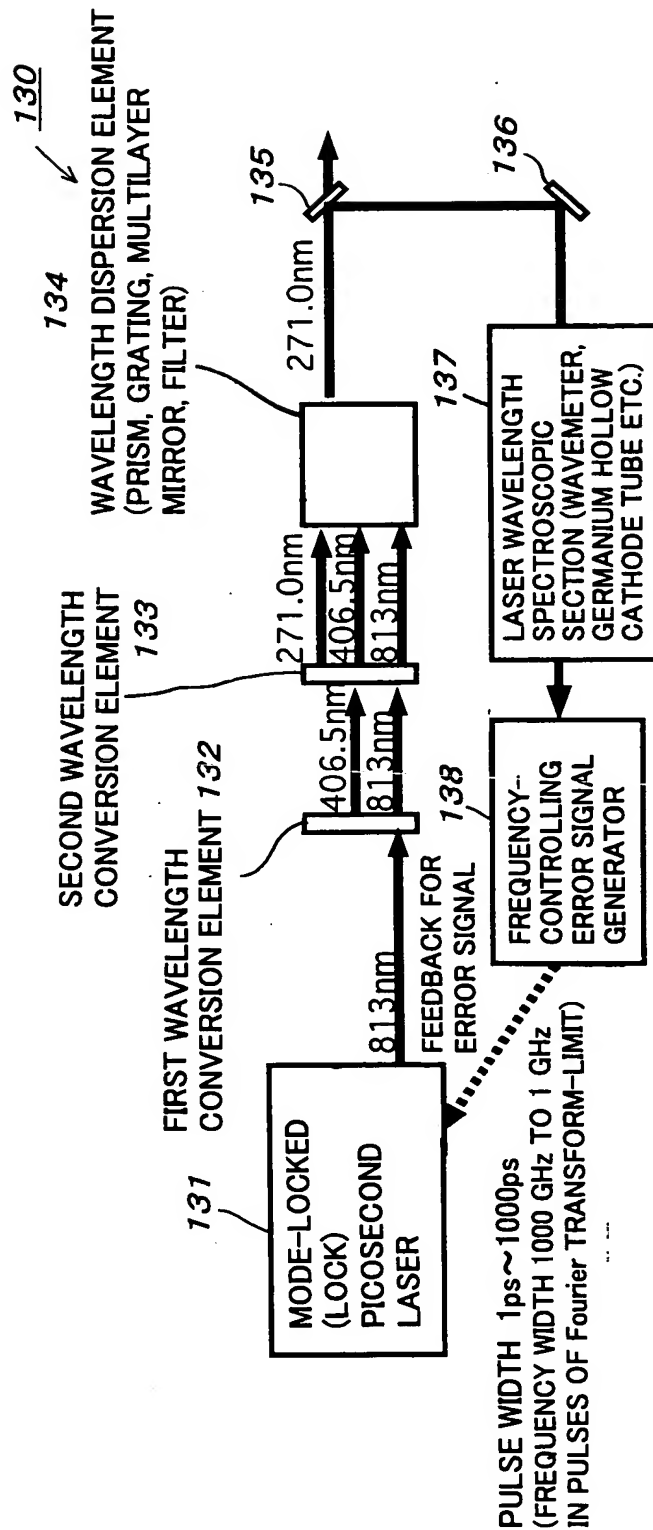


FIG. 18

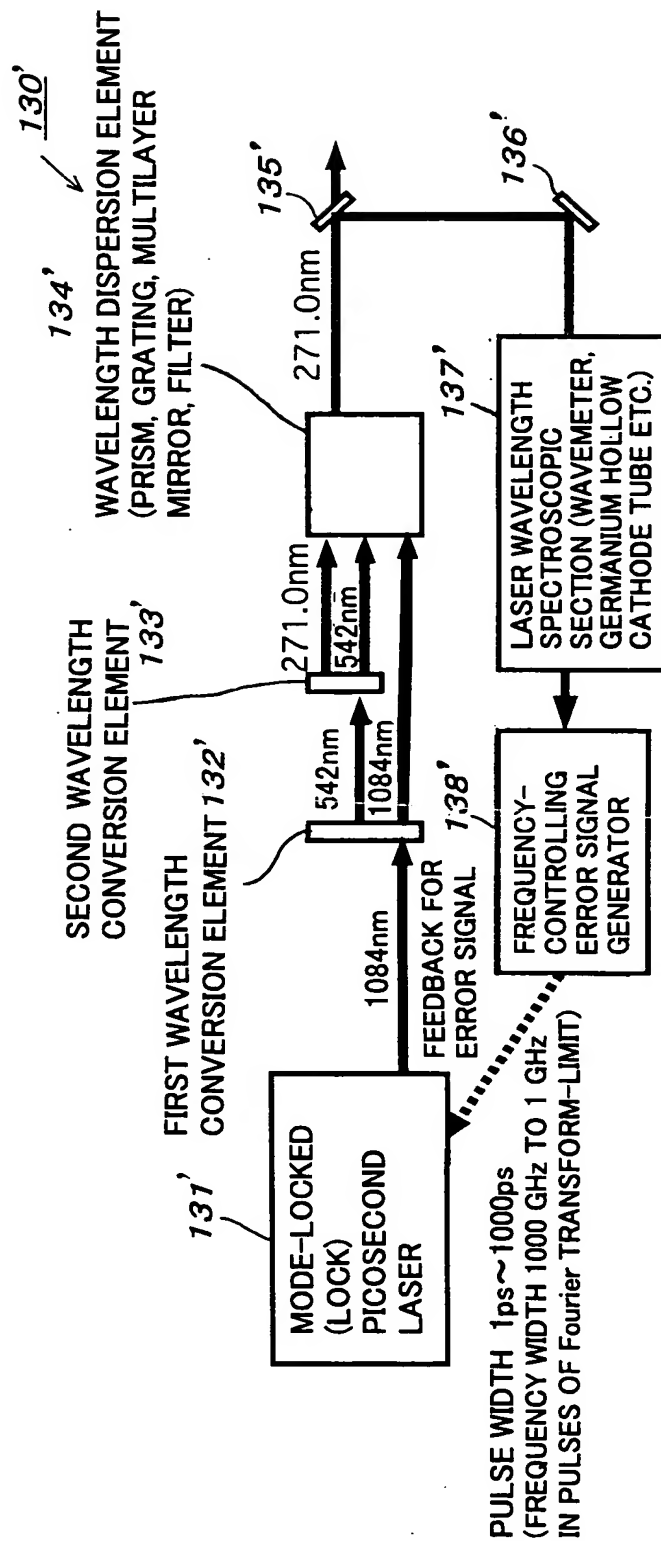
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM
DECELERATION: 271 nm WAVELENGTH



406.5 nm CORRESPOND TO SECOND HARMONICS OF 813 nm,
AND 271 nm CORRESPOND TO THIRD HARMONICS OF 813 nm

FIG. 19

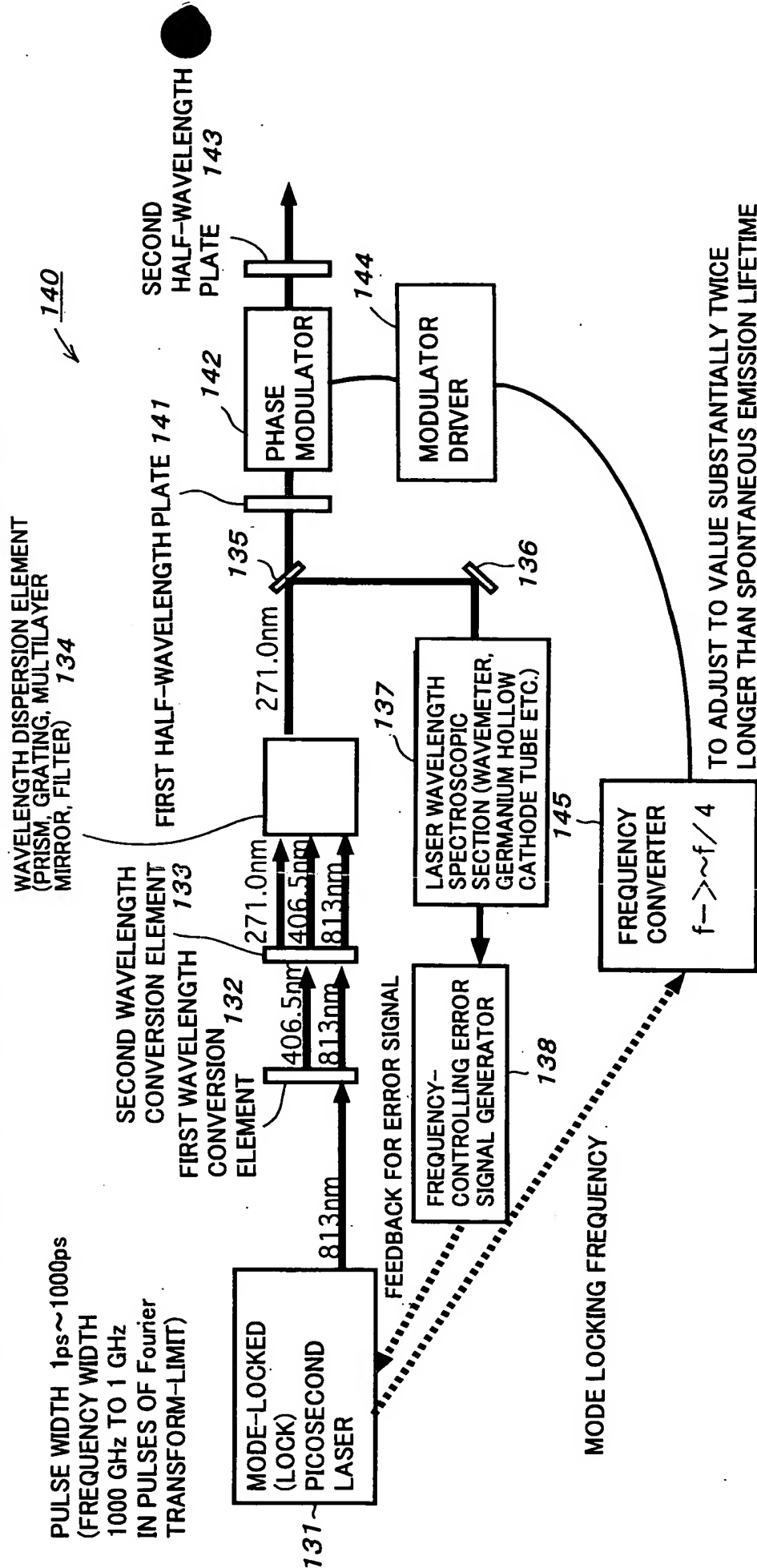
PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM
DECELERATION: 271 nm WAVELENGTH



542 nm CORRESPOND TO SECOND HARMONICS OF 1084 nm,
AND 271 nm CORRESPOND TO SECOND HARMONICS OF 542 nm

FIG. 20

PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH



406.5 nm CORRESPOND TO SECOND HARMONICS OF 813 nm,
AND 271 nm CORRESPOND TO THIRD HARMONICS OF 813 nm.

PICOSECOND COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH

**PULSE WIDTH 1ps~1000ps
(FREQUENCY WIDTH
1000 GHz TO 1 GHz
IN PULSES OF Fourier
TRANSFORM-LIMIT)**

WAVELENGTH DISPERSION ELEMENT
(PRISM, GRATING, MULTILAYER
MIRROR, FILTER) 134'

SECOND WAVELENGTH
CONVERSION ELEMENT
FIRST WAVELENGTH 133'

SECOND
FIRST HALF-WAVELENGTH PLATE 141'

**MODE-LOCKED
(LOCK)
PICOSECOND**

131-

1084nm

FREQUENCY- CONTROLLING ERROR SIGNAL GENERATOR

**LASER WAVELENGTH
SPECTROSCOPIC
SECTION (WAVEMETER
GERMANIUM HOLLOW
CATHODE TUBE ETC.)**

MODULATOR

MODULATOR

MODE LOCKING FREQUENCY

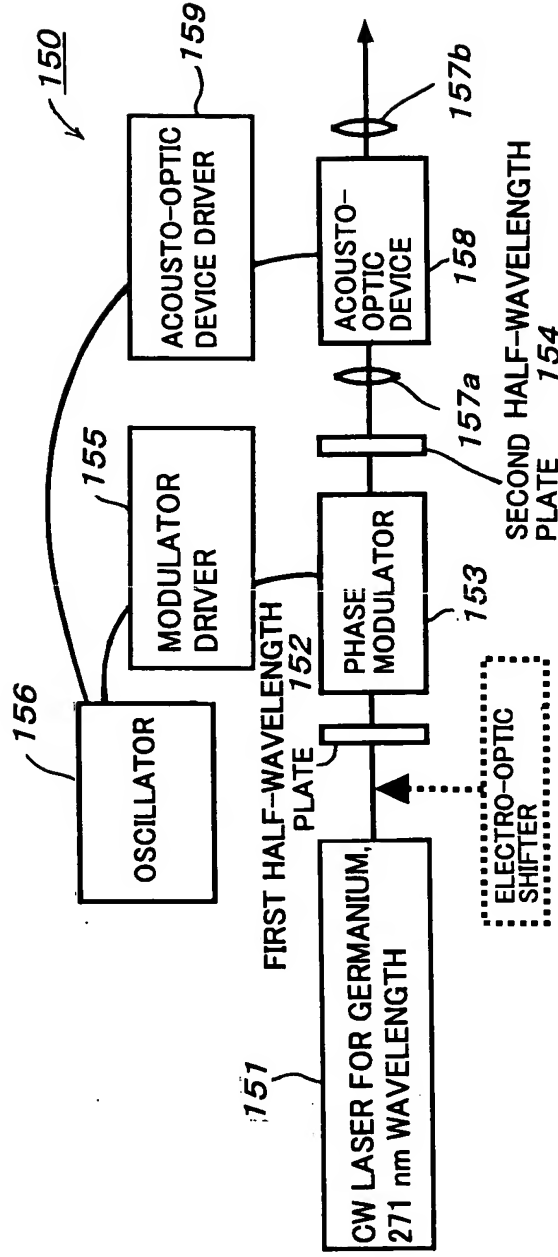
FREQUENCY CONVERTER

TO ADJUST TO VALUE SUBSTANTIALLY TWICE
LONGER THAN SPONTANEOUS EMISSION LIFETIME

542 nm CORRESPOND TO SECOND HARMONICS OF 1084 nm, AND 271 nm CORRESPOND TO SECOND HARMONICS OF 542 nm

FIG. 22

CW COHERENT LIGHT SOURCE FOR GERMANIUM DECELERATION/COOLING TO WHICH POLARIZED LIGHT CONTROL FUNCTION HAS BEEN ADDED: 271 nm WAVELENGTH



GERMANIUM DECELERATION: FREQUENCY IS CHANGED TIME-VARYINGLY BY
 USE OF ACOUSTO-OPTIC DEVICE (CHIRPED COOLING)
 GERMANIUM COOLING: ACOUSTO-OPTIC DEVICE HAS EFFECT FOR SEPARATING POLARIZED
 LIGHT AND ADVANTAGEOUS FOR OPTIMIZING FREQUENCY

THERE IS CASE EFFECTIVE FOR CHIRPED COOLING BY INCREASING
 FREQUENCY SHIFT AMOUNT WITH ADDITION OF ELECTRO-OPTIC SHIFTER (EO SHIFTER)